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Photosensors with front-end IC

S16429 series

Built-in gain-stabilized APD suitable for short pulse light detection

This device is for direct TOF (time-of-flight) distance measurement, integrating a Si APD and a transimpedance amplifier. A gain-stabilized APD (GS APD) is used, and there is little gain fluctuation relative to temperature fluctuation, so there is no need for a temperature sensor or microcontroller. It has an increased high-band cutoff frequency (S16429-01CT: 300 MHz) of the transimpedance amplifier compared to previous products, realizing high-speed response.

Features

- **Stable gain against temperature fluctuations**
- **No gain adjustment according to individual differences required**
- **Built-in high-speed transimpedance amplifier**
  S16429-01CT: 300 MHz
  S16429-02CT: 280 MHz
- **Low noise**
- **No ringing**

Applications

- **Distance measurement**
- **Presence or absence of objects**

Structure

Parameter	Symbol	S16429-01CT	S16429-02CT	Unit
Detector	-	Si APD S15415-02	Si APD S15415-05	-
Photosensitive area*1	A	ϕ0.2	ϕ0.5	mm
Package	-	Glass epoxy		-
Sealing material	-	Silicone resin		-

*1: Area in which a typical gain can be obtained

Absolute maximum ratings

Parameter	Symbol	Condition	Value	Unit
Supply voltage (for transimpedance amplifier)	Vcc max		4.0	V
Reverse voltage (for APD)	V_APD		0 to V_{BR}	V
Photocurrent (DC)	I_L max		0.2	mA
Incident pulse light level*2	Ppulse		5	W
Operating temperature	Topr	No dew condensation*3	-40 to +105	°C
Storage temperature	Tstg	No dew condensation*3	-40 to +125	°C
Transimpedance amplifier chip temperature	Tj		150	°C
Soldering temperature*4	Tsol		260 (twice)	°C

*2: FWHM=1 ns (repetition frequency: 1 kHz)
*3: When there is a temperature difference between a product and the surrounding area in high humidity environments, dew condensation may occur on the product surface. Dew condensation on the product may cause deterioration in characteristics and reliability.
*4: Reflow soldering, JEDEC J-STD-020 MSL 4, see P.7
Note: Exceeding the absolute maximum ratings even momentarily may cause a drop in product quality. Always be sure to use the product within the absolute maximum ratings.

Electrical and optical characteristics [Ta=25 °C, Vcc=3.3 V, AC coupling + 50 Ω load, dark state]

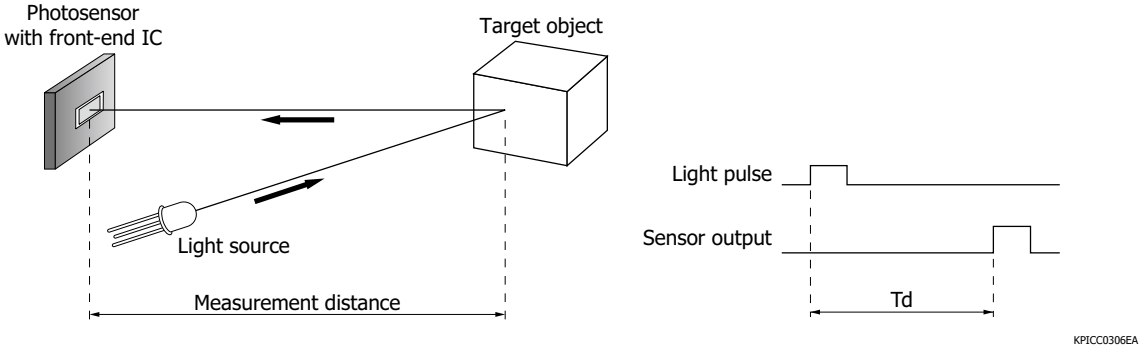
Parameter	Symbol	Condition	S16429-01CT			S16429-02CT			Unit
			Min.	Typ.	Max.	Min.	Typ.	Max.	
Spectral response range	λ		400 to 1100			400 to 1100			nm
Peak sensitivity wavelength	λp		-	840	-	-	840	-	nm
Photosensitivity	S	λ=905 nm, M=1	-	0.5	-	-	0.5	-	A/W
Breakdown voltage*5	VBR	Vcc=0 V, ID=10 μA Gain_APD terminal: open*6 *8	180	200	220	180	200	220	V
Operating reverse voltage	Vop	Gain-stabilized mode operation*7 *8	185 + 1.1 × (Ta opr - 25)*9	-	-	185 + 1.1 × (Ta opr - 25)*9	-	-	V
Temperature coefficient of operating reverse voltage	ΔTVop	*8	0.95	1.1	1.25	0.95	1.1	1.25	V/°C
Dark current*5	ID	Gain-stabilized mode operation*7	-	20	200	-	40	400	pA
APD gain*5	M	Gain-stabilized mode operation*7 λ=905 nm	40	50	60	40	50	60	-
Transimpedance amplifier gain	G	Differential	-	30	-	-	30	-	kV/A
Current consumption	Icc		-	45	65	-	45	65	mA
High-band cutoff frequency	fch		200	300	-	180	280	-	MHz
Equivalent input current noise*5	en	f=100 MHz	-	6	9	-	6	9	pA/Hz$^{1/2}$
Output impedance*5	Zo	f=100 MHz	-	50	80	-	50	80	Ω
Maximum output voltage amplitude	Vp-p max	Differential	0.4	0.7	-	0.4	0.7	-	V
Supply voltage	Vcc		3.135	3.3	3.465	3.135	3.3	3.465	V
DC current rejection*5	Idc		1	-	-	1	-	-	mA

*4: APD gain is stabilized by connecting a constant current source to the anode (see P.5 "Temperature characteristics of output waveform").
*5: Reference values defined by simulation or characteristic evaluation
*6: Opening the Gain_APD terminal enables operation as a typical APD instead of a GS-APD
*7: Apply bias voltage to anode. IR anode limit=10 μA
*8: Ta opr=assumed maximum operating temperature
*9: Characteristics for APD only

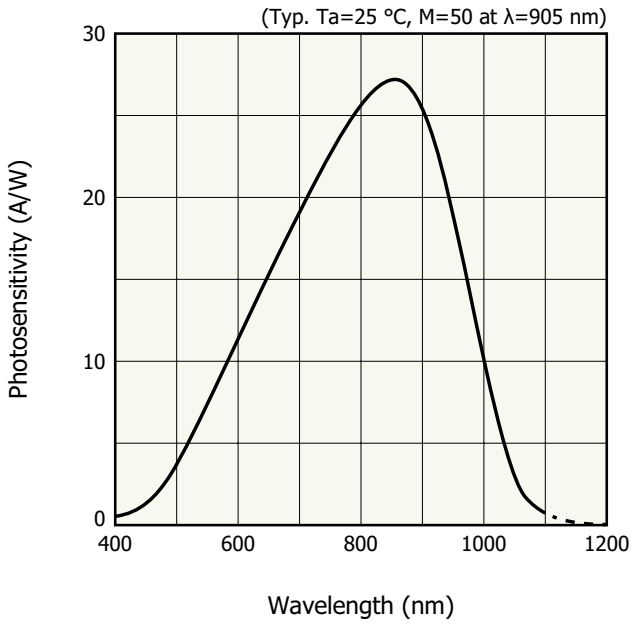
Distance measurement method

Distance L is calculated from the speed of light c and the time difference Td between the light source's light emission timing and sensor output.

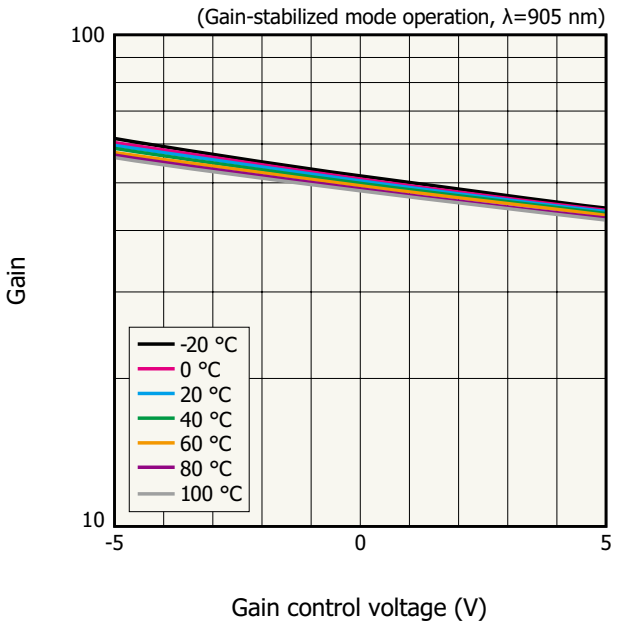
L = (1/2) × c × Td



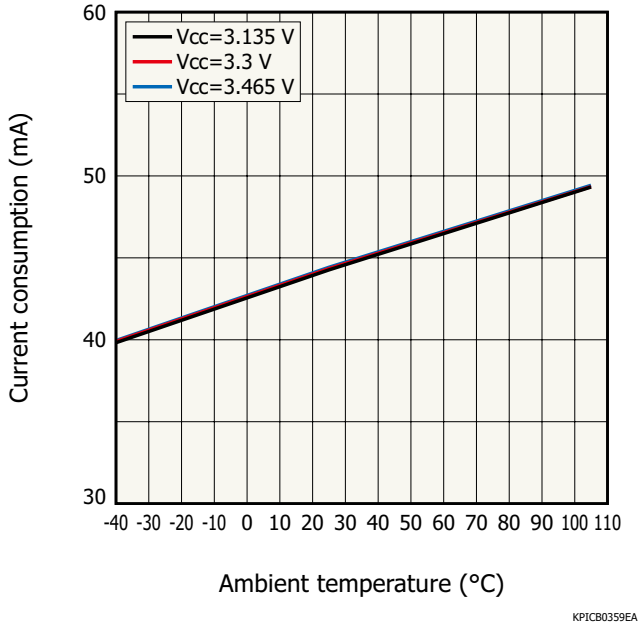
Spectral response



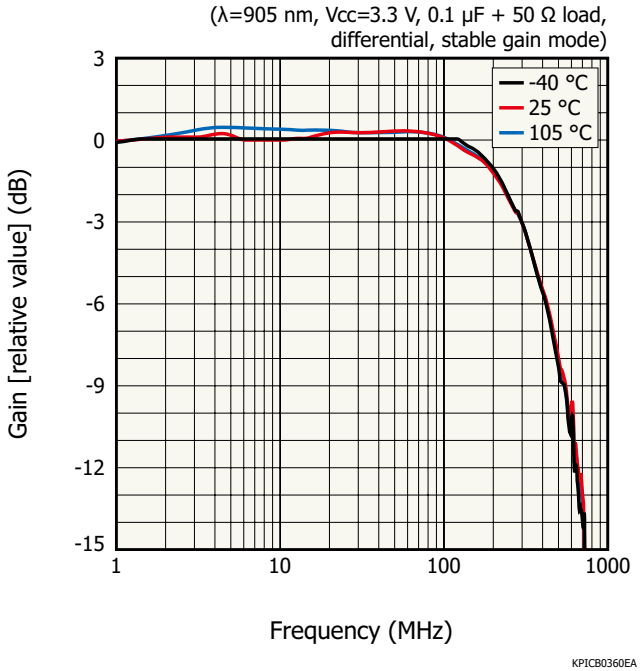
Gain vs. gain control voltage (typical example)



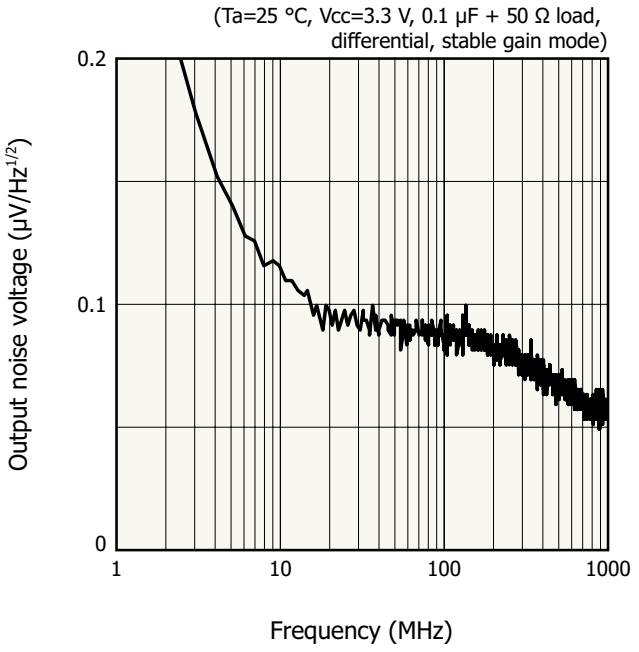
Current consumption vs. ambient temperature (typical example)



Frequency characteristics (S16429-01CT, typical example)



Output noise voltage vs. frequency (S16429-01CT, typical example)



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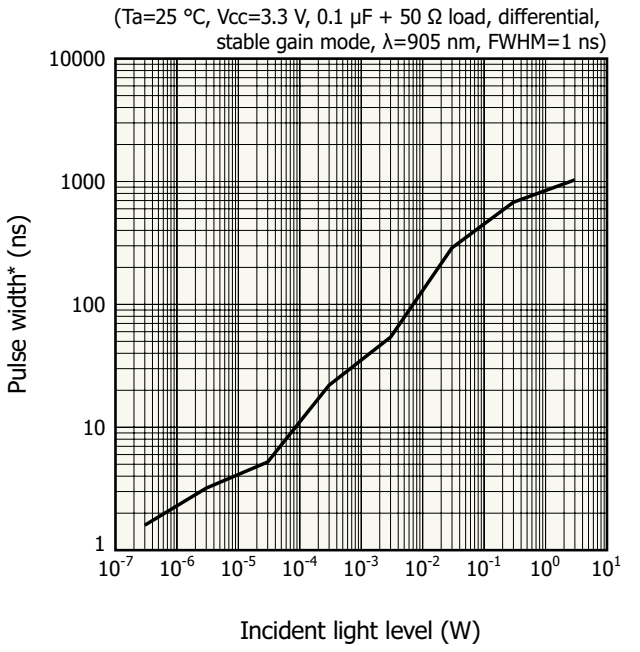
Output pulse width vs. incident light level (typical example)



* Measured output voltage 200 mV as a threshold value

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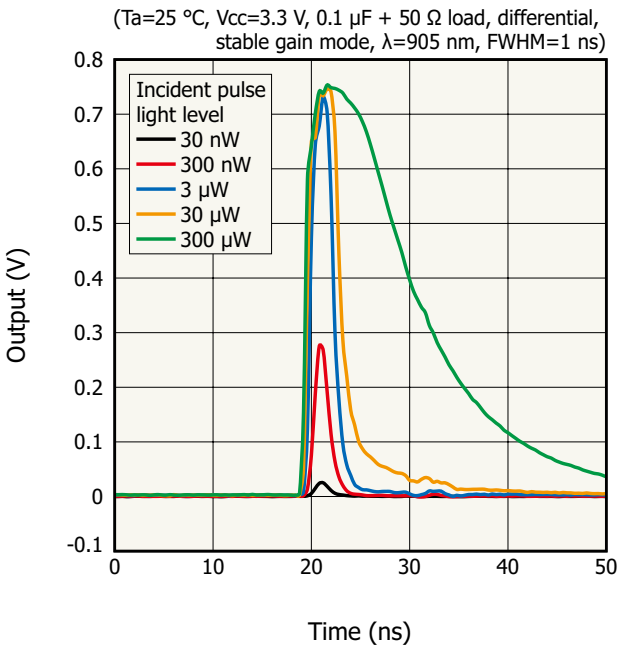
Output waveform (S16429-01CT, typical example)



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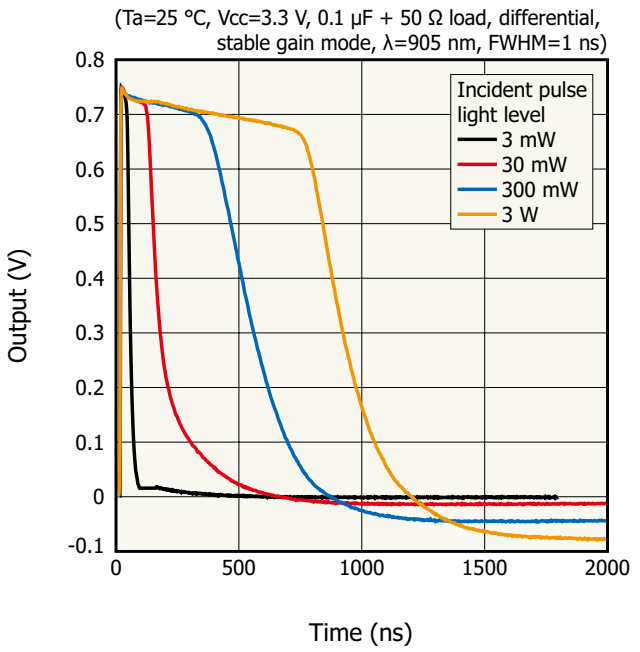

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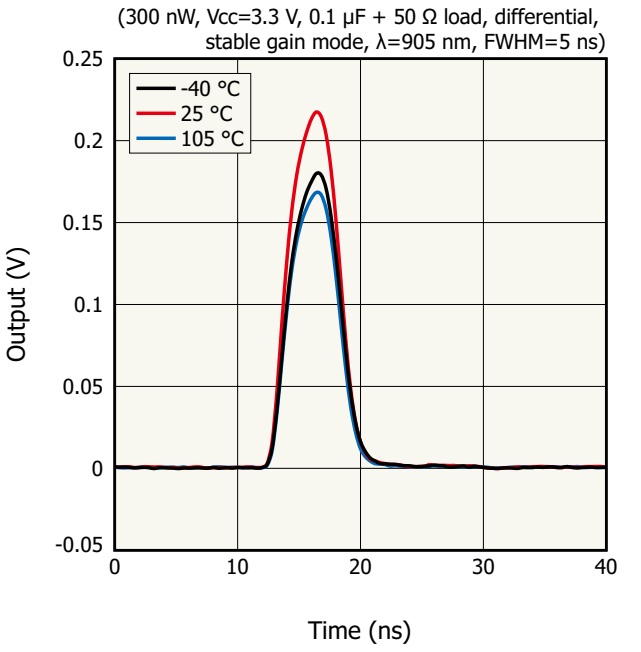
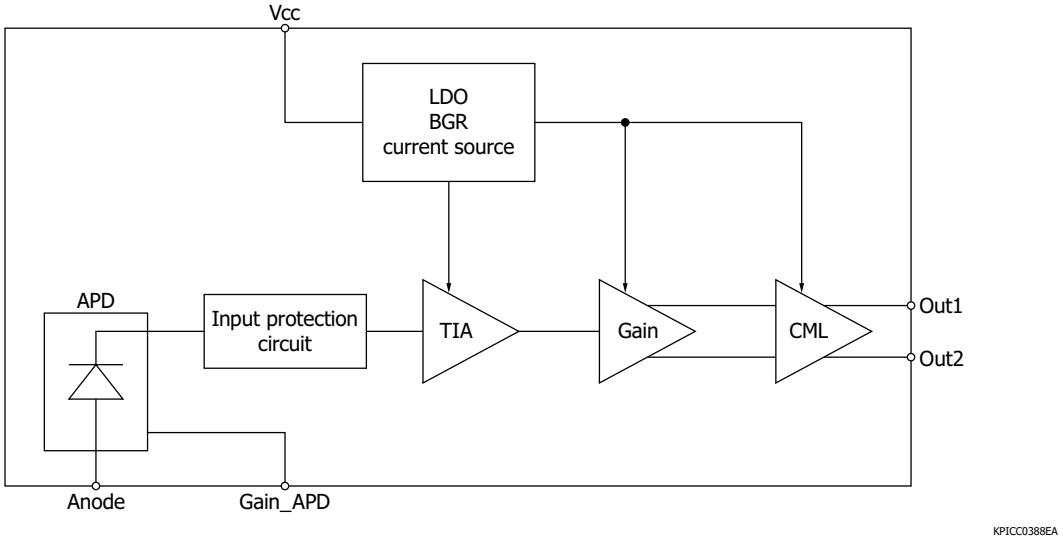
Temperature characteristics of output waveform (typical example)

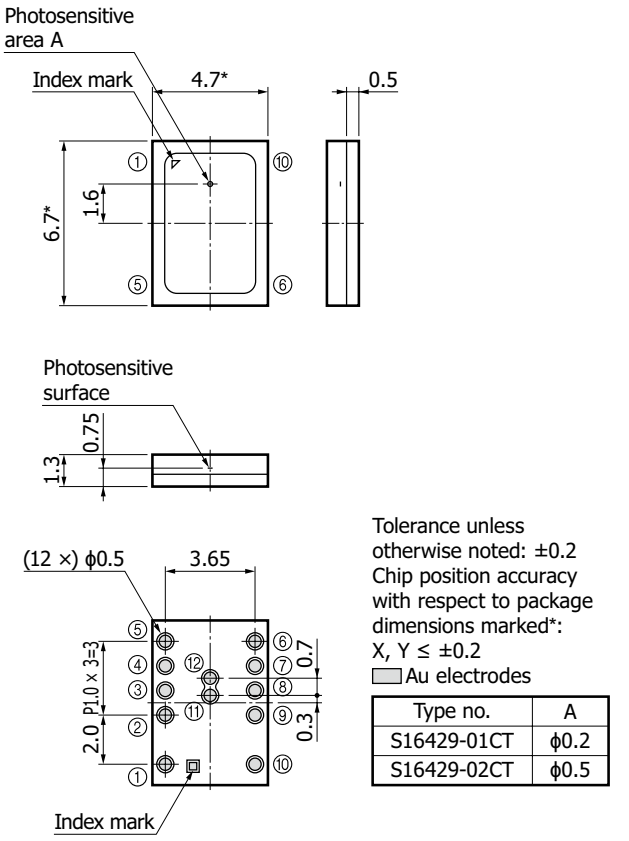


Block diagram



TIA (Transimpedance Amplifier) integrates DCFB (DC feedback) circuit. The DCFB circuit detects the DC component of photocurrent, and reduces the effects of background light through the differential processor.

Dimensional outline (unit: mm)



Tolerance unless otherwise noted: ±0.2
Chip position accuracy with respect to package dimensions marked*:
X, Y ≤ ±0.2
Au electrodes

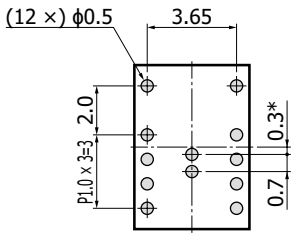
Type no.	A
S16429-01CT	ϕ0.2
S16429-02CT	ϕ0.5

KPICA0118EA

Pin connections

Pin no.	Function
1	Gain_APD
2	NC
3	NC
4	NC
5	Out2 (negative)
6	Out1 (positive)
7	GND
8	Vcc
9	NC
10	Anode
11	GND
12	GND

Recommended land pattern (unit: mm)



Tolerance unless otherwise noted: ±0.1
* Distance from package center to pad center

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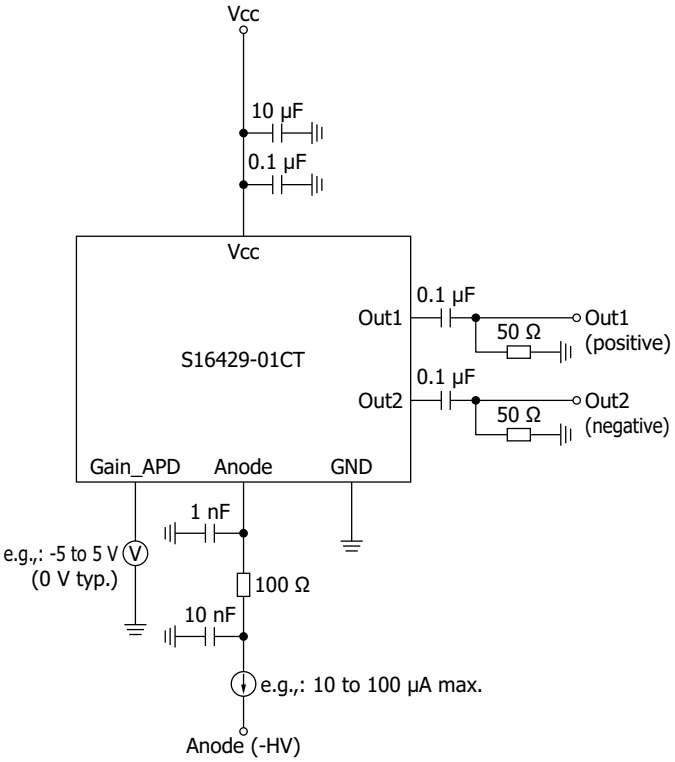
Precautions

· Apply high voltage to the anode terminal. Beware of electric shock.
· Apply negative voltage with respect to GND (-165 V, etc.) to the anode terminal.
· The top of the package is silicone resin. Be careful not to pinch it too hard with metal tweezers, as this can cause cracks or flakes.

Operating circuit example

Stable gain mode



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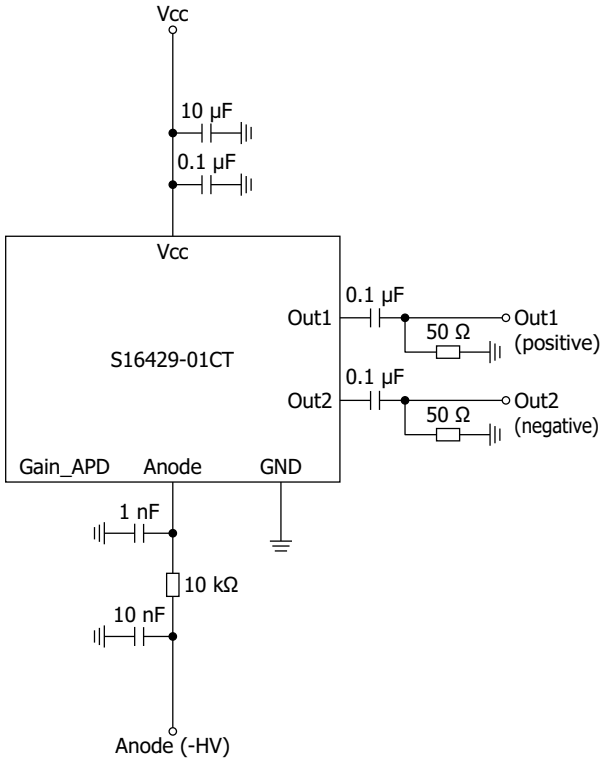
Normal APD mode



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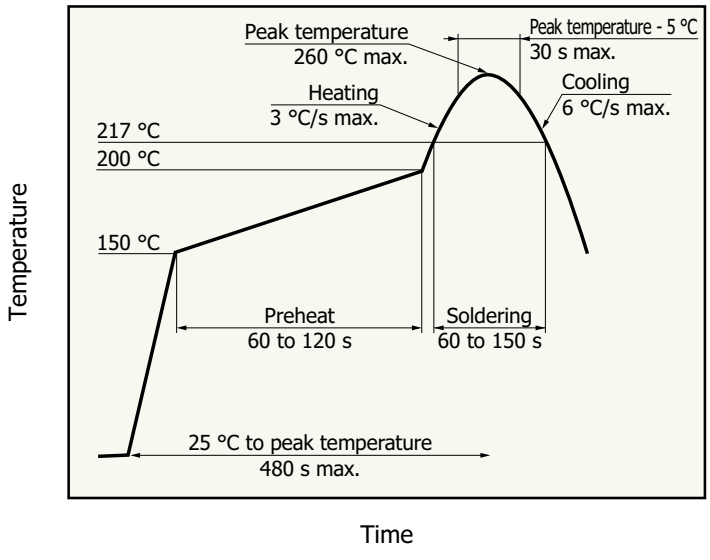
Recommended reflow soldering conditions



KSPDB0419EA

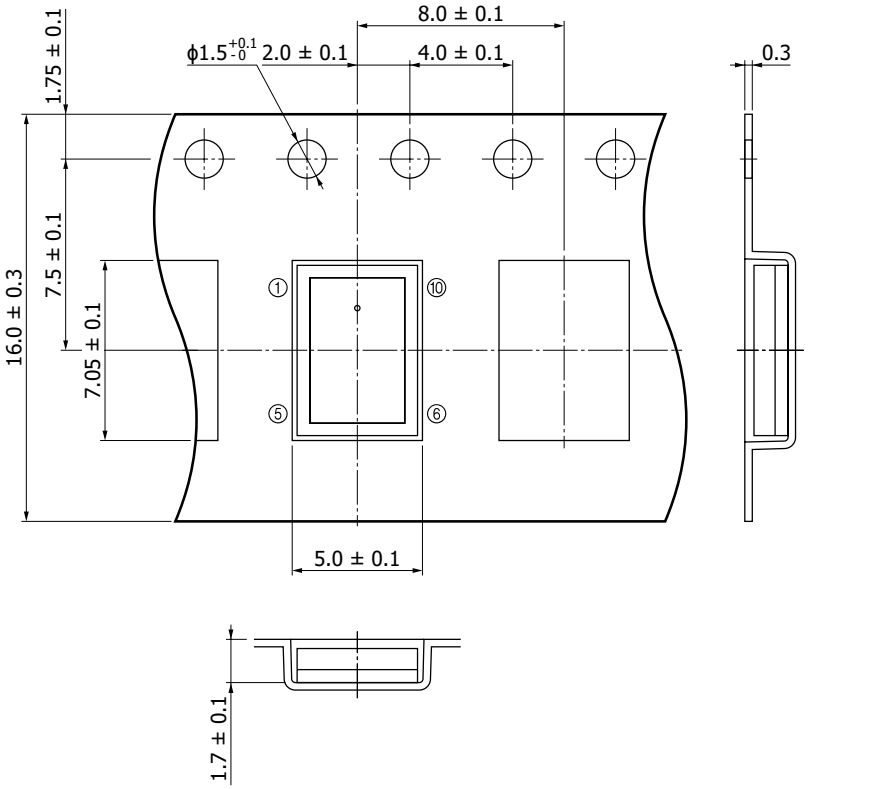
· This product supports lead-free soldering. After unpacking, store it in an environment at a temperature of 30 °C or less and a humidity of 60% or less, and perform soldering within 72 hours.
· The effect that the product receives during reflow soldering varies depending on the circuit board and reflow oven that are used. When you set reflow soldering conditions, check that problems do not occur in the product by testing out the conditions in advance.

Reel packing specifications

■ Reel (conforms to JEITA ET-7200)

Outer diameter	Hub diameter	Tape width	Material	Electrostatic characteristics
ϕ254 mm	ϕ100 mm	16 mm	PS	Conductive

■ Embossed tape (unit: mm, material: PS, conductive)



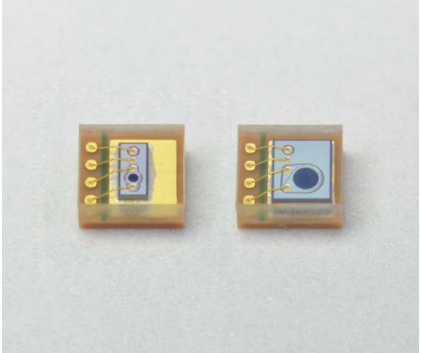
■ Packing quantity
1000 pcs/reel

■ Packing state
Reel and desiccant in moisture-proof packing (vacuum-sealed)

Related products

Si APD S15415 series

This is a surface mount type Si APD with the built-in photodetector chip of the S16429 series, mounted in a silicone COB package. This realizes constant gain without the need for temperature adjustment.



Features

- **Built-in temperature compensation function**
- **Compact package: 2.0 × 1.8 × 0.85^{t} mm**
- **High-speed response: cutoff frequency=500 MHz typ.**

Type No.	Photosensitive area	Photosensor with front-end IC
S15415-02	ϕ0.2 mm	S16429-01CT
S15415-05	ϕ0.5 mm	S16429-02CT

Related information

www.hamamatsu.com/sp/ssd/doc_en.html

■ Precautions
· Disclaimer
· Precautions / Surface mount type products

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